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# Expert Report
## *Limitations of Dust Sampling Methodology*

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**W.R. Grace & Company**
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### Qualifications

Dr. Richard J. Lee obtained a Bachelor of Science degree in physics from the University of North Dakota in 1966 and a Ph.D. in theoretical solid state physics from Colorado State University in 1970. He then went to Purdue University as an Assistant Professor in physics where he taught courses on the principles of optical microscopy. He received tenure at Purdue in less than two years.

In 1973, Dr. Lee went to work for United States Steel (US Steel), first as a research scientist and thereafter, as director of their physics and electron microscopy department in the Technical Center. He remained at the US Steel Research Center until 1985. While at US Steel, he analyzed a wide range of materials and was employed by NASA to analyze moon rocks brought back by the Apollo missions.

During his tenure at US Steel Research, Dr. Lee was responsible for developing the first techniques for quantitatively identifying amphibole asbestos fibers and cleavage fragments by a combination of transmission electron microscopy and energy dispersive X-ray analysis. He participated in the original ASTM committee that developed and evaluated the first TEM methods for preparing samples of air, bulk and water for the determination of asbestos content. Dr. Lee was the first scientist to develop methods for distinguishing asbestos amphiboles from cleavage fragments using transmission and scanning electron microscopy.

Since 1985, Dr. Lee has been President of a company now known as RJ Lee Group, Inc., ("RJ Lee Group") which has its principal office in Monroeville, Pennsylvania, and laboratories in San Leandro, California; and Manassas, Virginia. RJ Lee Group provides research, analytical and consulting services relating to materials characterization. Materials characterization of bulk building materials, also referred to as "constituent analysis", involves analyzing a sample of material using various techniques to identify and quantify the components of that material.

Dr. Lee has a long history of scientific consulting and service for government agencies, including the United States Environmental Protection Agency (EPA). RJ Lee Group's laboratory serves as a quality assurance and referee laboratory on a number of EPA programs. RJ Lee Group's laboratory performed the analyses for the EPA's major study on airborne levels of asbestos in public buildings. Dr. Lee has participated in the development by the EPA of analytical methods and procedures for asbestos analyses. The

EPA requested that he personally participate in several projects, including the drafting of the portions of the Agency's AHERA regulations governing air sample analysis after abatement. Dr. Lee was an invited member of the Health Effects Institute - Asbestos Research literature review panel, sponsored by the EPA. RJ Lee Group also has performed analyses for the United States Navy, the United States Army and the United States General Services Administration. Dr. Lee developed a program to determine the cause of failure in components of the guidance system in the Trident missile for the Department of the Navy.

RJ Lee Group's laboratory has also performed microscopic analyses for the State of California Air Resources Board when that agency performed testing of the air in major cities in the State of California to determine the presence of asbestos.

Dr. Lee is now engaged in and specializes in materials characterization, which is the science that uses a variety of analytical techniques to determine the identity and amount of each component of a material. He has performed materials characterization analyses on many samples of vermiculite produced from different sources for over 15 years. He is familiar with all methods of microscopy that are commonly used in characterizing asbestos or identifying and quantifying asbestos, including optical microscopy, scanning electron microscopy and transmission electron microscopy. He is also familiar with all known methodologies, from air sampling to dust sampling, with respect to asbestos. Dr. Lee is a member of the ASTM committee that has developed the dust sampling methods now in question. He has worked extensively with, and is an expert in, analytical techniques including light and electron microscopy, materials characterization, asbestos air, bulk, and dust samples, and methods of evaluation. He has also served as an expert witness in litigation involving asbestos in buildings and has testified in state and federal courts.

Dr. Lee is familiar with airborne levels of asbestos fibers both in buildings and in outdoor air, the sources of asbestos in the outside or ambient air, scientific knowledge and techniques regarding the measurement of levels of asbestos in the air, the development and use of the technology to measure both airborne levels of fibers and levels in materials samples, and the standards and methods used for air sampling. He has been involved in analyzing and producing bodies of air sampling data for EPA and other governmental and private entities including analysis of samples taken in an ongoing nationwide study of airborne levels in buildings and his analysis of air samples taken in an EPA-sponsored study in Texas.

He is also familiar with the history of standards governing asbestos including the current standards, regulatory positions and philosophies,

different types of asbestos fibers, asbestos fiber levels as reported in the literature, as well as his own work concerning buildings with asbestos-containing materials.

Dr. Lee's fee for consulting, depositions, and trial appearances is $350 per hour.

## Summary of Opinions

Dust sampling and analyses, as applied to dust and debris from in-place building materials, are not reproducible.

The reported asbestos concentrations for dust samples do not accurately represent the concentration of asbestos in surface dust and debris. The use of the "indirect" sample preparation method for analyzing surface dust modifies the collected material by shaking and sonicating the sample in an acidic solution. Data derived from "indirect" preparation have very large variability; the number of asbestos structures is exaggerated due to the sample preparation procedure.

Because of the "indirect" sample preparation procedures used for dust analyses, the dust methods are particularly unsuited for analyzing debris from a cementitious fireproofing or acoustical plaster product. The "indirect" method dissolves the matrix materials binding the asbestos fibers together, generating or liberating individual, free asbestos fibers that were not present as such in the surface dust.

Dust sampling and analyses are not recognized within the scientific or regulatory communities as a means of assessing or predicting inhalation exposure and have not been incorporated into any regulatory standards for such use.

Dust sampling and analyses provide no information on past or future concentrations of respirable asbestos fibers that are or may be in the air.

## Physical Characteristics, Composition and Properties of Fireproofing Acoustical Plaster Materials

Fireproofing materials are applied to the surface of decks, beams and other structural members of buildings. Sprayed on fireproofing containing asbestos was applied by either wet or dry methods beginning in the late 1950's through the early 1970's. In the dry method, the materials are blown through a tube and mixed with water at the point of application. In the wet process, the materials are mixed with water, then pumped through a tube and sprayed on structural steel. In both cases, the action of a water-

activated binder causes them to stick to the surface and when dried or set, form a resilient cohesive coating.

The primary requirement of fireproofing materials applied to steel structures is that they both prevent the spread of fire and protect the steel structure against deformation, at least for sufficient time to permit safe evacuation of building occupants. Thus, they must be fire resistant: they must provide a mechanism for the safe dissipation of heat away from the steel members which they protect and they must retain their integrity, both long term over the life of the building and short term when subjected to a fire episode.

Acoustical plaster materials were applied to ceilings and walls of buildings. The materials were sprayed-on or troweled on depending on the particular use. As applied, water would cause a chemical bonding to take place in the product encapsulating any fibers in the product. These materials (with asbestos) were in use from the late 1950's through the early 1970's.

The general composition of the acoustical plaster products was a binder (cement or plaster of paris) combined with a light-weight aggregate (vermiculite or perlite), asbestos (chrysotile), and sometimes some clay (montmorillonite or bentonite). Other additives were used to improve setting, increase the whiteness of the product, or reduce bacterial growth in the product.

The principal function of acoustical plasters is to reduce ambient levels of sound in a room by partial adsorption of the sound and by selective reflection of the sound. The products, while providing an architecturally acceptable surface finish, adhere to building materials such as ceiling decking, metal duct work, and other wallboard or plaster finishes.

Some of the binder materials also undergo a chemical reaction with water, precipitating onto and encapsulating the remaining particles; these reacted materials are known as cementitious.

The American Society for Testing and Materials (ASTM), an organization which defines terms, standards and testing methods for materials, defines a cementitious material as "A material that, when mixed with water, with or without aggregate, provides the plasticity and the cohesive and adhesive properties necessary for placement and the formation of a rigid mass". Implicit in this definition is the ability of the material to adhere to the structure to which it is applied not only during application but also after setting up in place. The constituents of these WR Grace fireproofing and acoustical products are such that the material meets ASTM's definition of cementitious.

## Asbestos-Containing Fireproofing and Acoustical Plaster Materials do not Spontaneously Degrade or Shed Individual, Free Fibers

The constituents of the cementitious fireproofing materials and acoustical plasters at issue are stable and do not spontaneously degrade or shed individual fibers even when physically or chemically attacked.

Constituents which were used in the WR Grace products, in addition to minor quantities of asbestos, were plaster, gypsum and vermiculite. Thus, the materials used in the formulation of the products at issue are, after setting, chemically inert with respect to normal building conditions. The bonding action between the cementitious matrix and its fiber reinforcement results in products which are dimensionally stable and possess excellent cohesion by virtue of the reinforcing action of the asbestos fibers in their formulations. They do not degrade or release components spontaneously. They do not spontaneously delaminate or lose adherence if they are correctly applied and if the building is properly maintained.

When applied and maintained appropriately, these products will withstand degradation due to impact, bending, compression and air erosion. The materials of interest in this case are inert, non-reactive materials. They have been consolidated into a system which in and of itself will not degrade or deteriorate. Unless improperly applied, or subjected to adverse environmental conditions, these materials will maintain their integrity.

The components of these materials are found in nature giving rise to their intrinsic stability. The asbestos is encapsulated or otherwise tightly enmeshed by the primary constituents and itself becomes an interlocking member of the system. Even when mechanically disturbed or intruded upon the system will fracture in such a manner as to release debris particles, not individual respirable asbestos fibers.

These materials have been subjected to a variety of air erosion tests[1,2,3] which demonstrated, within the state-of-the-art, that they did not release individual asbestos fibers. In addition, RJ Lee Group has subjected the

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1 Boyle Engineering Laboratory (1965). Report of Air Velocity Surface Erosion Test on Firecode Plaster, Test performed for United States Gypsum Company, September 1965.

2 Boyle Engineering Laboratory (1967). Report of Effect of High Velocity Air Upon the Surface of Mono-Kote Material Having a Dry Bulk Density of 16.85 lbs. per cu. ft., performed for Zonolite Division, W.R. Grace & Company, January 16-20, 1967.

3 D. Keyes, W. Ewing, and S. Hays (1990). "Recent Research on Fiber Release from ACM and Re-entrainment of Asbestos Dust", Session 20, presented at the National Asbestos Council Seventh Annual Asbestos Abatement Conference and Exposition, San Antonio, TX.

fireproofing material to extensive pulverization tests[4] demonstrating that no significant airborne fiber levels were generated by the action.

## Dust Sampling and Analysis

Dust sampling and analysis is a methodology by which dust is collected from a surface and the content of asbestos evaluated. The dust may be collected by a technique known as a microvacuum or a microvac, in which a partial vacuum is created at a membrane filter surface and dust particles pulled from a surface are deposited either on the filter surface or in the cassette holder. A variety of other methodologies are also employed including application of a sticky surface (adhesive lift) sample to the dust to collect particles, or wiping a damp cloth or filter (wipe sample) over the surface. The analysis of these samples for asbestos content can be performed by optical or electron microscopy.

Sample preparation of surface dust samples is accomplished utilizing an "indirect" methodology. In the indirect analysis particles are removed from collection media, suspended in acid water, and subjected to mechanical agitation (currently employing ultrasonic treatment). The sonication time varies from three to fifteen minutes. A portion of the suspended material is then deposited onto a membrane filter for microscopic analysis.

The development of the dust procedures began in the 1980's as an outgrowth of AHERA building inspections. During these inspections, dust was observed on the top of ceiling tiles, on top of bookshelves, or other areas which were not routinely cleaned. It was theorized that this dust may contain asbestos, but there were no published methods for the collection and analysis of this matrix. RJ Lee Group participated in the formulation and development of these dust sampling analytical methods.

### EPA Dust Protocol

In 1989, the U.S. Environmental Protection Agency (EPA) hosted a meeting in Cincinnati to discuss dust sampling and analysis. The outgrowth of this meeting was a draft EPA protocol[5] which was designed to improve "the degree of precision for this analysis". However, as noted by the method, the accuracy of the method was in question as "no single type of microscope can accurately cover the entire range of fiber sizes without relatively over- or under-estimating asbestos concentrations".

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[4] RJ Lee Group, Inc. (1995). Videotape: The Measurement of Fiber Release During Pulverization of Friable Fireproofing, September 29, 1995.

[5] P. J. Clark and K. Brackett (1990). "Draft Test Method for Sampling and Analysis of Dust for Asbestos Structures by Transmission Electron Microscopy", U.S. Environmental Protection Agency, Cincinnati, OH.

Though developed as a standard procedure, the dust procedure was never meant to be used alone. As noted in the draft EPA procedure: "This technique will augment visual inspection and air monitoring". Thus, it provides supplementary information to the primary building survey techniques - visual inspection, air monitoring and bulk sample analyses. The method was also designed to collect all dust on a surface, even extremely adherent dust where "a small spatula may have to be used to dislodge the particulates before microvacuuming the surface".

More significantly, the EPA acknowledged that the sample preparation procedure for the microvacuum method increases the number of counted asbestos fibers: "As this method involves the use of sonication to disperse the fibers in the dust sample prior to dilution and filtration, it will increase the number of small fibers counted in relation to what may have actually been found on the surface." The manner in which "indirect" preparation alters the number and character of asbestos structures in the dust is discussed in detail below.

**ASTM Dust Procedures**

The draft EPA procedure was submitted to the ASTM asbestos committee (currently D22.07) for consideration and development into a standardized method. The development by ASTM of standardized methods is the result of a consensus procedure. The methods do not require a unanimous vote to be approved, only a super-majority affirmative vote of the committee members. Disagreements and negative votes on balloted items are discussed at biannual meetings. Negative ballots must be considered, but can be deemed "non-persuasive" by a super-majority of the attending committee members. Thus, a method having been approved does not imply unanimous agreement - there may be technical issues unresolved but acceptable to a majority of committee members.

Balloting on the surface dust method began in early 1990 with a final consensus version not completed until 1995. At that time, the microvacuum method, ASTM D-5755-95[6], was issued. That method involves collection of samples by a microvacuum, indirect sample preparation, and results reported as the number of asbestos structures per square centimeter of sampled surface. During its five year development, significant changes were made to the method, both qualitative and quantitative, following vigorous committee discussions. In addition, a parallel method (ASTM D-5756-95)

[6] The published ASTM dust methods can be found in volume 11.03 of the *Annual Book of ASTM Standards*, American Society for Testing and Materials, Conshohocken, PA.

that measures the mass of asbestos in surface dust was started in 1993 and moved through balloting in tandem with the structure count method.

The ASTM methods include directives and guidance that delineate the usefulness and limitations of the method. The method is limited to the "general testing of non-airborne dust samples for asbestos". As noted, the "collection efficiency of this technique [microvaccum] is unknown and will vary among substrates". Like the draft EPA protocol, the ASTM method also acknowledges that the indirect sample preparation procedure "may alter the physical form of the mineral fibers".

One of the fundamental changes made to the draft EPA method when converting it into an ASTM method was to modify the definition of "dust". The draft EPA defined dust particles as 20 µm and smaller. In the ASTM methods, however, a much larger sized particle, 1 mm and smaller, was embodied in the definition. Because the sample collection nozzle is passed over a surface on which a range of particle sizes may occur, any particle that can fit into the nozzle will be collected, not just particles that may be respirable in size. Therefore, the definition of dust was increased to the larger size.

Considerable variation has taken place and continues to take place in the application of the microvacuum sampling and analysis methodology for settled dust. Thus, no scientifically viable conclusion may be drawn from dust samples collected in this manner.

Furthermore, despite the efforts of ASTM to develop standard methods, sample collection is far from standardized. For example, some practitioners apply pressure on the surface sampled in order to dislodge dust from it. Such pressure is not called for in the ASTM standards because it is difficult if not impossible to accurately apply this pressure. Because the pressure will vary and have unpredictable results on the amount of material collected, data from one area cannot be reliably compared with data from other locations.

The ASTM methods specifically state that "no relationship has been established between asbestos-containing dust as measured by [these methods] and potential human exposure to airborne asbestos".

Following completion of the two microvacuum sampling methods, a third method was developed by the ASTM committee. Currently designated as D 6480-99, this method uses a wet wipe (such as a clean room wipe) to collect the surface dust. Unlike the microvaccuum technique which attempts to limit the collected particles to those smaller than 1 mm, the wipe procedure collects all particles deposited within a designated sampling area. The first

draft of the method was balloted in 1996; final balloting and passage of the method occurred in 1999.

## Dust methods do not measure the dust as it occurs on the surface

The sample preparation methods used in measuring the asbestos content of dust collected by the ASTM methods results in distortion of both the sizes and number of asbestos structures in the sample. In particular, ultrasonic treatment, especially in combination with the use of acidified water, so disrupts the asbestos particles present in asbestos-containing dusts as to nullify any attempt at estimating their number concentration.

The ability of ultrasonic energy to disrupt asbestos particles and split them into finer particles has not only been known for many years, but was in fact a basis for mineral beneficiation of chrysotile ores in the early 1960's.[7] Sample preparation procedures for transmission electron microscopic examination in the late 1960s and early 1970s was based on the use of ultrasonics. Spurny[8] reported on the effect of ultrasonic treatment of asbestos fibers, reporting on changes to the size and aspect ratio of fibers. In studies of asbestos in water, Chatfield[9] quantified the breakup of asbestos by ultrasonics and showed how it increased with time and input power. Chesson[10] conducted a statistical study of comparisons of direct and indirect preparation of air samples and showed that in all cases the number of fibers observed in indirect preparations were higher than in direct preparations. Burdett[11] compared direct and indirect sample preparation and concluded that the indirect method modified the fiber count by breaking up agglomerates and that the direct preparation procedure was useful for exposure assessment.

Sahle[12] and Kauffer[13] similarly showed that indirect sample preparation induces very high apparent fiber concentrations due to the action of

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[7] E. Martinez (1963). "Effect of Ultrasonic Energy on Chrysotile Asbestos", Transactions of AIME, p. 388 - 390.

[8] K. R. Spurny, W. Stöber, H. Opiela, and G. Weiss (1980). "On the problem of milling and ultrasonic treatment of asbestos and glass fibers in biological and analytical applications", *American Industrial Hygiene Association Journal*, 41, p 198-203.

[9] E. J. Chatfield, R. W. Glass, and M. C. Dillon (1978). "Preparation of Water Samples for Asbestos Fiber Counting by Electron Microscopy," U.S. Environmental Protection Agency (EPA), EPA-600/4-78-011.

[10] J. Chesson and J. Hatfield (1990). "Comparison of Airborne Asbestos Levels Determined by Transmission Electron Microscopy (TEM) Using Direct and Indirect Transfer Techniques", U.S. Environmental Protection Agency (EPA), EPA 560/5-89-004.

[11] G. Burdett (1985). "Inter-laboratory Comparison of the U.S. Environmental Protection Agency School Samples by the UK Health and Safety Executive", report no. IR/DI/86/03.

[12] W. Sahle and I. Laszlo (1996). "Airborne Inorganic Fibre Level Monitoring By Transmission Electron Microscope (TEM): Comparison Of Direct And Indirect Sample Transfer Methods," *Annals of Occupational Hygiene*, 40, p. 29-44.

ultrasonic treatment, which results in the breakdown of fibers in both length and diameter.

Our own work has shown that ultrasonic treatment results in the breakup of fireproofing debris particles, as well as the break-up of asbestos fibers of the size present in asbestos-containing fireproofing. We have demonstrated[14] that this breakup occurs early in the ultrasonic process. Through the use of ultra slow motion videography, we have demonstrated that this breakup is often explosive and instantaneous when the ultrasonic power is applied, with massive disruption of debris particles from an asbestos-containing fireproofing or of Grade 7M asbestos particles occurring within three seconds of application of the ultrasonic power. We have performed an inter-laboratory comparison of the effect of indirect preparation on single particles of fireproofing and asbestos bundles.[15] The results demonstrate that a single non-respirable particle of fireproofing products, when subjected to the sample preparation procedures of the indirect microvac protocol, produces the equivalent of hundreds of millions of fibers in the final result.

Lee[16] points out that the dilutions used by various laboratories also differ significantly and contribute to large variability between laboratories. Variations in dilution factors are thus likely to account for more variability than does location of the sample.

Because the matrices of the cementitious fireproofing and plaster materials are soluble in acid, the dust method's use of acidified aqueous suspension results in the dissolution of these matrices and consequential release of asbestos fiber bundles that would otherwise remain encapsulated in the fireproofing. Once released, these fiber bundles are more susceptible to ultrasonic disruption than they would be when held in their cementitious matrix. Consequently, the combined use of ultrasonic treatment and acidified aqueous suspensions synergistically leads to enhanced fiber breakup and thus to artificially increased concentrations of fibers in the dust. As a result, the fiber bundles observable to the naked eye become subdivided into numerous smaller fibers.

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[13] E. Kauffer, M.A. Billon-Galland, J.C. Vigneron, S. Veissiere and P. Brochard (1996). "Effect of Preparation Methods on the Assessment of Airborne Concentrations of Asbestos Fibres by Transmission Electron Microscopy", *Annals of Occupational Hygiene*, 40, p. 321-330

[14] RJ Lee Group (1993). Videotape: Ultrasonic Breakup of Chrysotile Grade 7M and Fireproofing", March 2, 1993.

[15] R. J. Lee, T. Dagenhart, G. Dunmyre, I. Stewart, and D. Van Orden (1995). "Effect of Indirect Sample Preparation Procedures on the Apparent Concentration of Asbestos in Settled Dusts", *Environmental Science & Technology*, 29, p 1728 – 1736.

[16] R. J. Lee, D. Van Orden, G. Dunmyre, and I. Stewart (1996). "Interlaboratory Evaluation of the Breakup of Asbestos-Containing Dust Particles by Ultrasonic Agitation", *Environmental Science & Technology*, 30, p. 3010 - 3015.

Every author reporting on comparison of direct and indirect preparation recognized that the indirect preparation method modifies the sample and increases the fiber count.[8,9,10,11,12,13,14,15,16] Those that have conducted detailed experiments conclude that the increase results from the break-up or dissolution of particles containing asbestos and from modification of the fiber size distribution, i.e., breakage of longer fibers into shorter fibers and bundles of fibers into individual fibers.[15,16,17] As a result the numerical concentration of asbestos reported by the ASTM dust procedures has no relationship to the asbestos structures as they occur in the dust on the surface.

Dement, a former Director of the National Institute for Environmental Health Sciences, succinctly summarizes the issue with indirect preparation when he states[18]: "The use of indirect sample transfer for transmission electron microscopy (TEM) of asbestos has been shown to break up the airborne fibers into smaller units. Depending upon the treatment, the observed concentration of fibers and their size distribution change drastically. There is no biological justification for such a violent treatment, and the measured entity is not a biologically justifiable measured quantity. Therefore, the use of indirect sample transfer method for asbestos sampling should be discouraged and the more gentle direct transfer method should be used."

In summary, the indirect ASTM dust procedures modify the sample making it impossible to evaluate whether asbestos in surface dust is individual, free and respirable fibers or particles of debris that have been broken up in the process.

## Surface dust in typical buildings with ACM does not readily become airborne

Surface dust does not readily become airborne. The particle size, cohesion and moisture content affect the ability of surface dust to be resuspended. High air velocities, in excess of 100 mph, were necessary to liberate asbestos fibers from a surface. Guillaman[19] found increased levels of fibrous particulate during periods of high activity in schools, but no increase in

[17] E. J. Chatfield (1999). "Correlated Measurements of Airborne Asbestos-Containing Particles and Surface Dust", *Advances in Environmental Measurement Methods for Asbestos*, ASTM publication STP 1342.
[18] J. Dement (1990). "Overview: Workshop on Fiber Toxicology Research Needs", *Environmental Health Perspectives*, 88, p. 261- 268.
[19] M. P. Guillaman and P. Madelaine (1989). "Asbestos in Buildings: The Difficulties of a Reliable Exposure Assessment", *Aerosol Science and Technology*, 11, p. 221 - 243.

asbestos concentrations. Guth[20] estimated the contribution of surface dust to airborne concentrations at less than 1% of the available particles.

A study by the Missouri Department of Health[21], cited by OSHA in their 1994 rulemaking, found that a variety of custodial activities including dry sweeping of asbestos-containing dust and debris produced airborne concentrations well below the OSHA limit. Our own analysis of air samples related to clean-up of asbestos-containing dust and debris following an earthquake found virtually all samples to be below the PEL[22].

Millette and Heffernan[23] reported concentrations well below the PEL when dry sweeping asbestos dust produced during a simulated maintenance activity.

## Dust sampling is not recognized as a means of exposure assessment

Dust sampling and analysis, in contrast to air sampling, is not recognized within the scientific, regulatory or industrial hygiene communities as a means of assessing or predicting exposures. It has not been incorporated into any regulatory standard, nor is there any literature correlating the results of microvacuum dust sampling to airborne concentrations of asbestos.

Mr. Michael Beard, formerly with EPA's Quality Assurance Branch in Raleigh, NC, was a frequent presenter at technical meetings, symposia and courses in the early 1990's. In courses on settled dust analysis, sponsored by the Georgia Institute of Technology, by the Environmental Information Association and by ASTM, Mr. Beard repeatedly stressed that EPA has neither an official method for the analysis of asbestos in settled dust nor an official policy for its use.

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[20] J. H. Guth (1990). "Interpretation og Surface Asbestos Contamination Data: The Closed Finite System Model, Update #1", presented at the NAC Fall Technical Conference, Phoenix, AZ.

[21] A. R. Wickman, D. W. Roberts, and T. L. Hooper. "Exposure of Custodial Employees to Airborne Asbestos", Missouri Dept. of Health Report to the EPA, EPA Project J1007468-01-0.

[22] D. Van Orden, R. Lee, K. Bishop, D. Kahane, and R. Morse (1994). "Evaluation of Ambient Asbestos Concentrations in Buildings Following the Loma Prieta Earthquake", *Regulatory Toxicology and Pharmacology*, 21, p. 117 - 121.

[23] MVA Inc. and P. Heffernan (1993). *Airborne Asbestos Levels During Simulated Maintenance Operation of Inspecting the Area above the Tile Ceiling in the Cafeteria of the Saltonstall Building in Boston*, Report of Results, MVA0376, prepared for the Commonwealth of Massachusetts, March 19, 1993.

## There is no correlation between dust sample results and airborne levels of asbestos

Results of microvac dust sampling bear no correlation or relationship to either past or potential airborne levels[24] in buildings. In fact, the ASTM dust method itself recognizes this limitation. The ASTM D5755 method states (section 5.1.2): "At present, no relationship has been established between asbestos-containing dust as measured by this test method and potential human exposure to airborne asbestos."

An extensive data set of air and dust samples collected in residential properties was evaluated to determine whether any correlation exists between airborne concentrations of asbestos and asbestos concentrations measured in settled dust. These samples were collected in buildings that were allegedly damaged during an earthquake in southern California. Interior airborne asbestos concentrations were higher than outdoor concentrations; indoor airborne levels did not correlate with asbestos concentrations in the dust as measured by the indirect ASTM TEM methods. The presence of asbestos in the surface dust was shown to be independent of the presence of asbestos in bulk samples collected from the residences. The presence of airborne asbestos was also shown to be independent of the presence of asbestos in surface dust. Thus, observing asbestos in a dust sample does not imply that asbestos will be found in an air sample nor does it imply that asbestos will be found at some predictable concentration.

Chatfield[25] has produced supporting documentation that shows the airborne particles from a controlled abrading of ACM are not correlated with dust that fell to the surface. He showed that the individual chrysotile fibers observed in the surface dust, when indirectly prepared in accordance with ASTM D5755, "could not have been present in the original dust and debris which settled" during the tests and that the "numbers, sizes and characteristics of the chrysotile structures ... were therefore not representative of the particles as they existed on the original surface".

Fowler and Chatfield[26] conclude that dust sampling has little value for predicting potential airborne concentrations especially if indirect

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[24] R. J. Lee, D. Van Orden, and I. Stewart (1999). "Dust and Airborne Concentrations – Is There a Correlation?", *Advances in Environmental Measurement Methods for Asbestos*, ASTM publication STP 1342.
[25] E. J. Chatfield (1999). "Correlated Measurements of Airborne Asbestos-Containing Particles and Surface Dust", *Advances in Environmental Measurement Methods for Asbestos*, ASTM publication STP 1342.
[26] D. P. Fowler, and E. J. Chatfield (1997). "Surface Sampling for Asbestos Risk Assessment," *Annals of Occupational Hygiene*, 41, Supplement 1. p 279-286.

preparation is used. Sansone[27] warns that interpretation of dust sample analysis and resuspension data is subject to many variables.

The EPA also notes that asbestos in dust and airborne asbestos are not related:[28] "At present no firm conclusions can be drawn regarding potential exposure hazards from asbestos contaminated surface dust and no limits have been set to define a level requiring abatement or cleaning of an area."

Richard J. Lee

Richard J. Lee
President

[27] E. B. Sansone (1987). "Redispersion of Indoor Surface Contamination and Its Implications", *Treatise on Clear Surface Technology*, Ed. K. L. Mittal, 1, p 261-290.
[28] P. J. Clark and K. Brackett (1990). "Draft Test Method for Sampling and Analysis of Dust for Asbestos Structures by Transmission Electron Microscopy", U.S. Environmental Protection Agency, Cincinnati, OH. The statement is in the Foreword to the method.